Karlsruhe Institute of Technology

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Session G4.1: Satellite Gravimetry

UNIVERSITÄT BERN

GPS-based gravity field recovery from reprocessed GOCE precise science orbits

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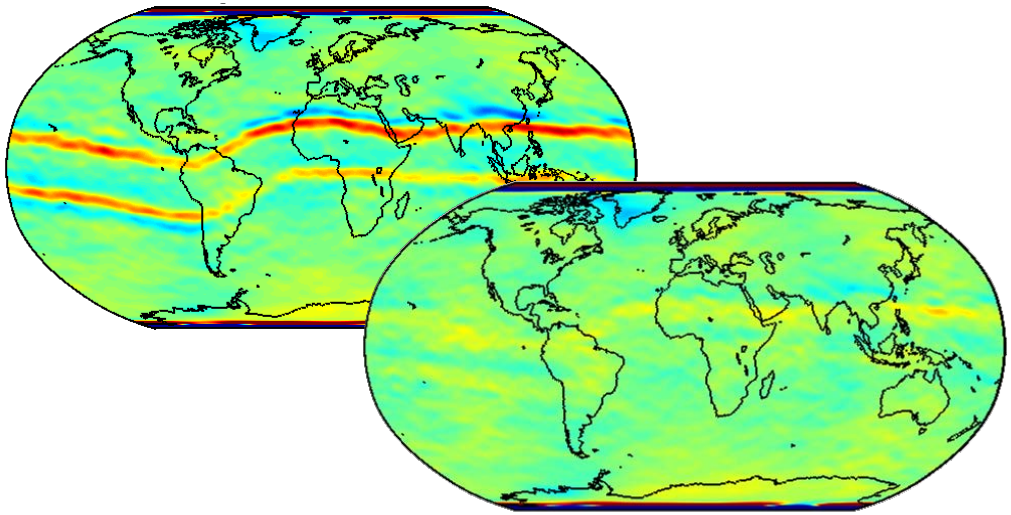
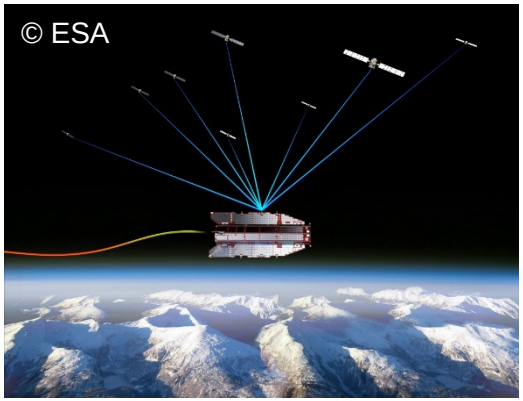
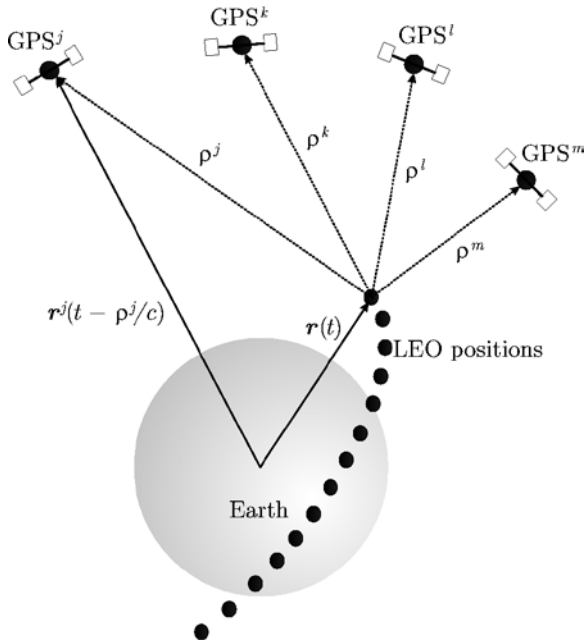


Introduction

- GOCE Precise Science Orbits (PSO)
  - GPS-based orbit determination via Satellite-to-Satellite Tracking (SST-hl)
  - Kinematic and reduced-dynamic orbits

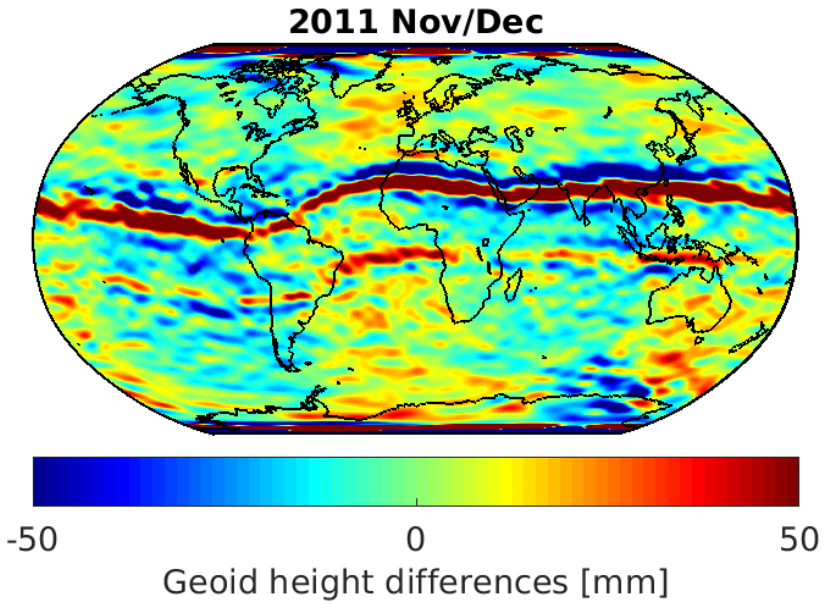


- Gravity field recovery
  - Kinematic orbit position are used to recover the long-wavelengths gravity field
  - Input for combined GOCE gravity field models (GPS + gradiometry)
  - Degradation of kinematic positons propagates into gravity field solutions



Motivation

- Gravity field recovery based on operational GOCE PSO (Jäggi et. al., 2015)



Ionosphere-induced artifacts along the geomagnetic equator

Differences w.r.t. ITSG-GRACE2016

(300 km Gauss-filtered)

Workaround: Exclusion of affected GPS observations from orbit determination

Problem: Degradation of orbit quality (→ not applied for official PSO product)

GOCE Reprocessing campaign: Reprocessing of GOCE PSO and gravity field recovery

Efforts within the GOCE Reprocessing Campaign (1/2)

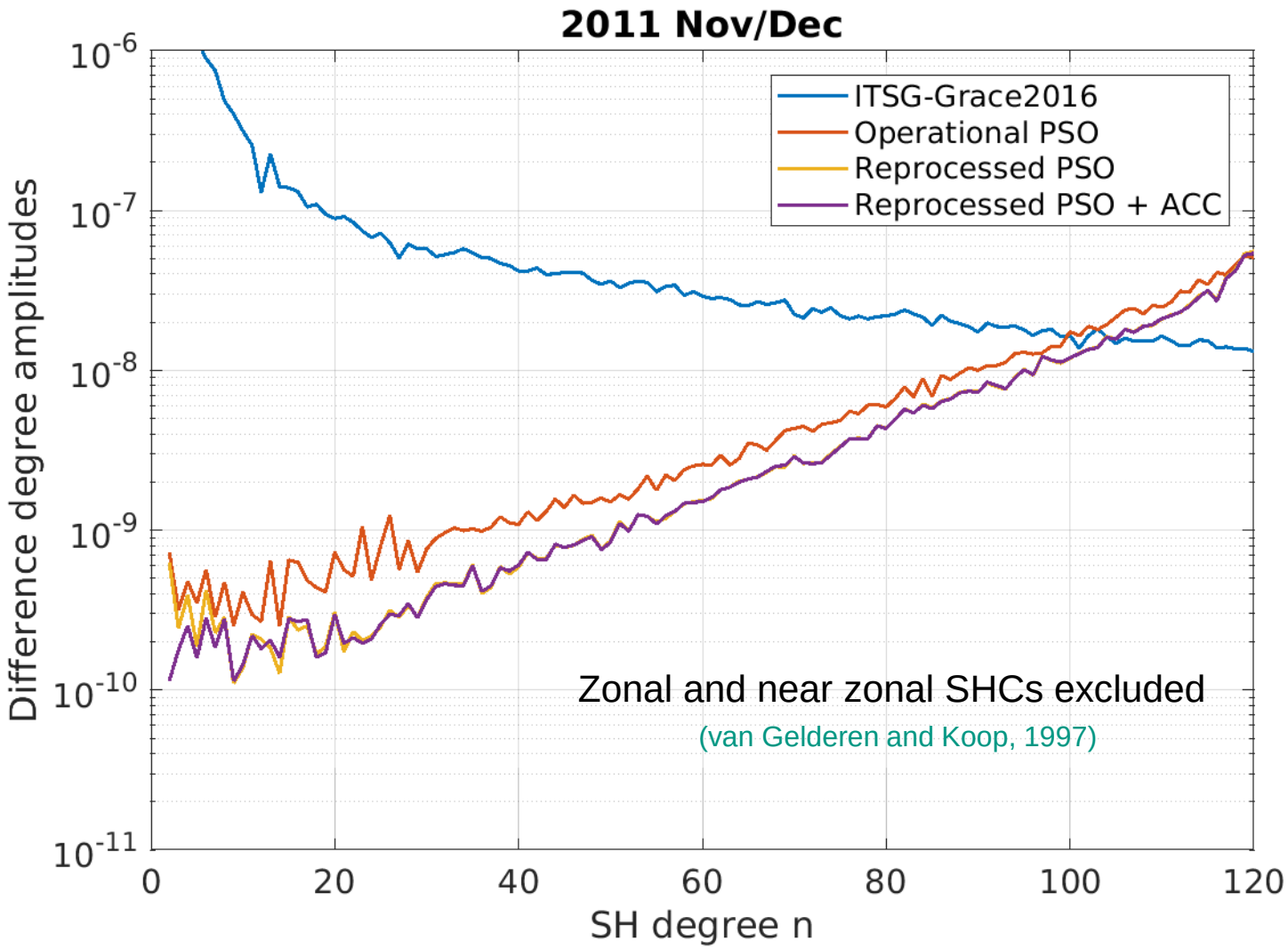
- Complete reprocessing of GOCE PSO
  - Bernese GNSS software using reprocessed GPS products (IGb08)
  - ➢ Down-weighting strategy to mitigate ionosphere-induced effects
    - Affected GPS observations get higher covariance values
    - Criterion 1: Large changes in geometry-free linear combination (2nd derivative)
    - Criterion 2: Large ROTI values (Rate Of TEC Index)
    - Performance is validated by orbit overlaps and SLR residuals

Efforts within the GOCE Reprocessing Campaign (2/2)

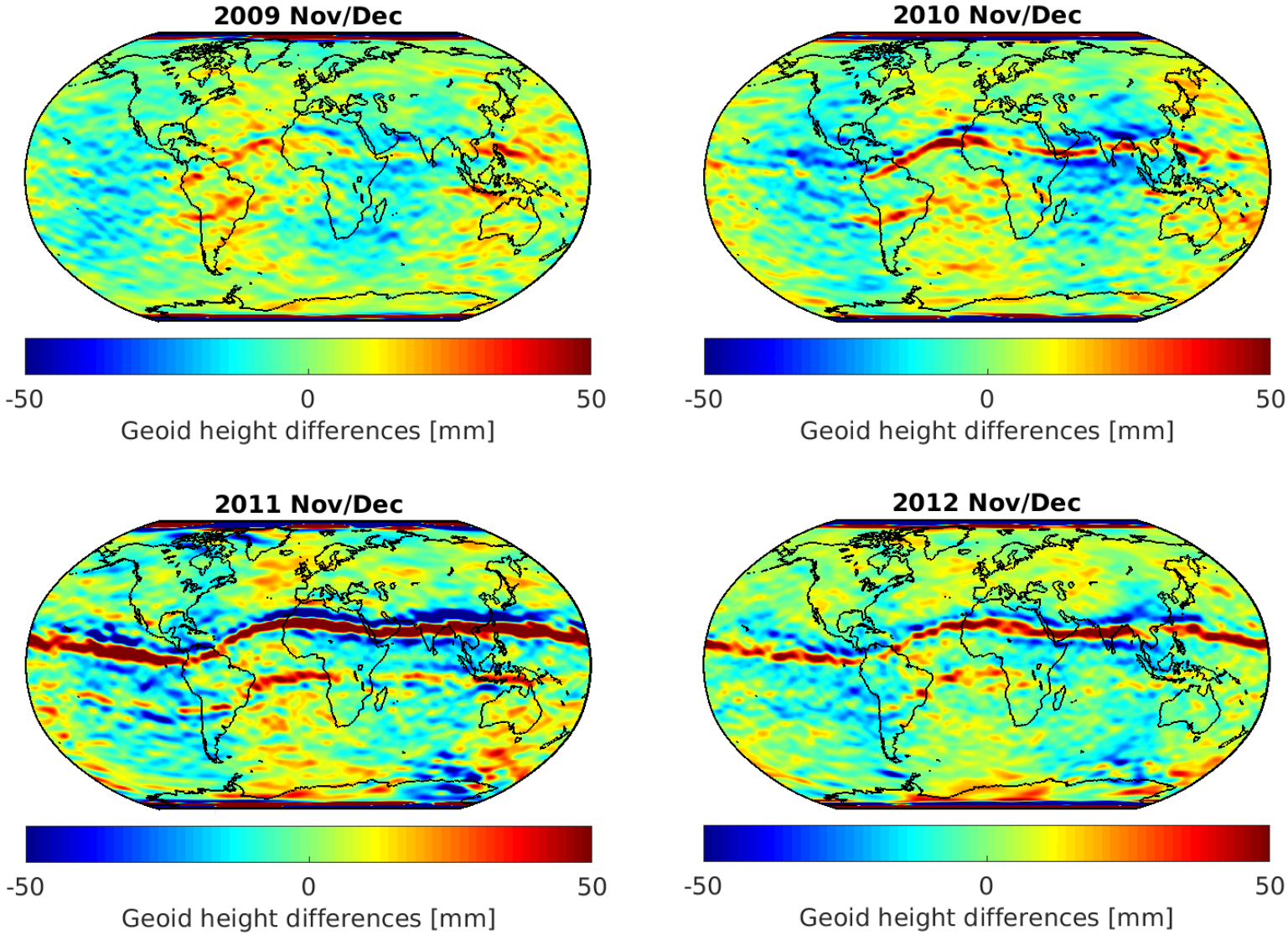
- Gravity field recovery (Celestial Mechanics Approach)
  - 1-sec reprocessed kinematic GOCE positions (epoch-wise covariance information)
  - Arc-specific orbit and gravity field parameters are estimated simultaneously
    - Six initial Keplerian elements for each 24-hour arc
    - Constant and once-per-revolution empirical accelerations over 24 hours
    - Pseudo-stochastic pulses each 6 minutes (constrained)
    - SH coefficients up to degree and order 120 (without regularization)
  - Use of GOCE accelerometer (ACC) data to improve lowest SH coefficients

- Gravity field solutions

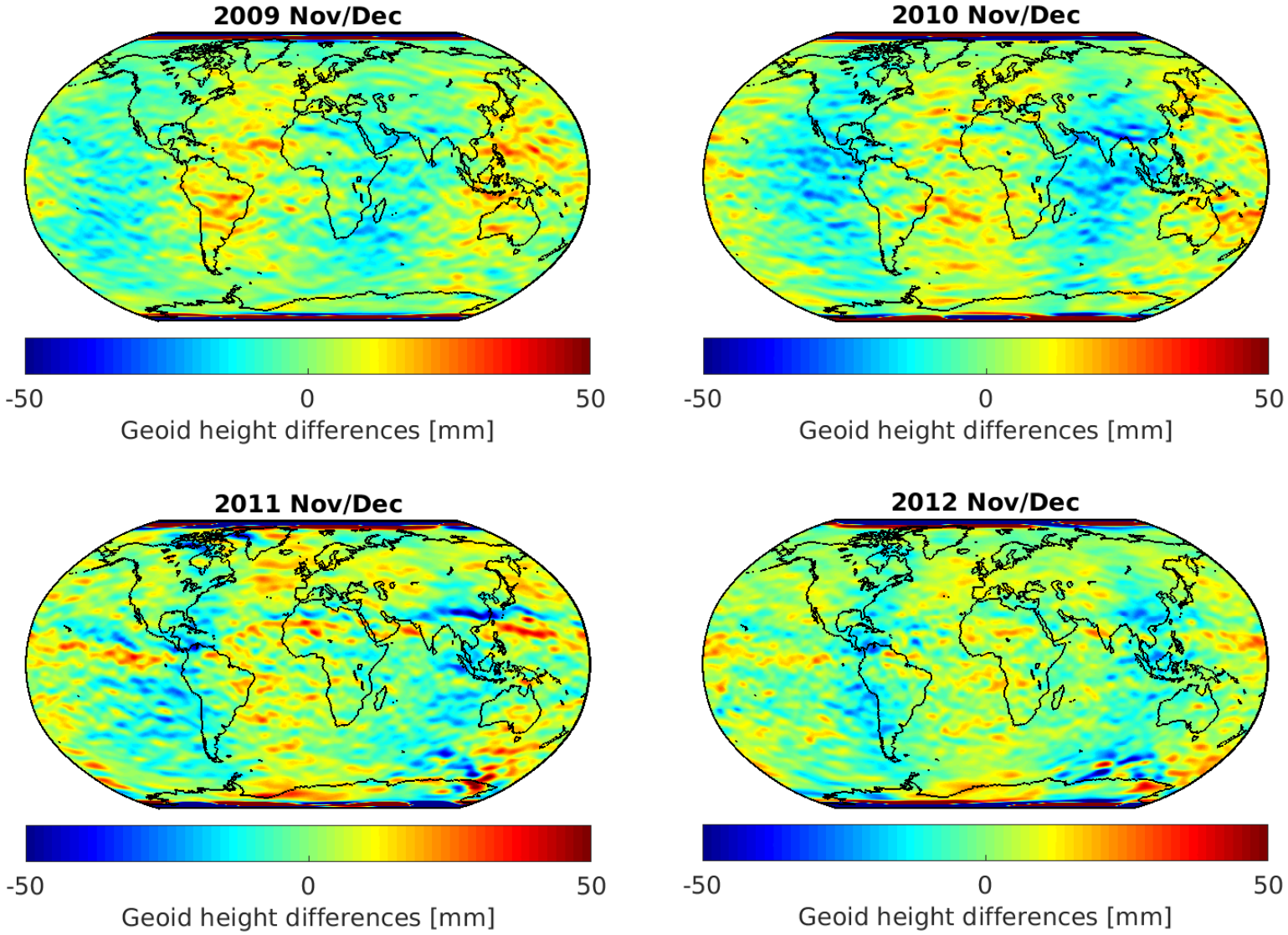
Gravity field recovery



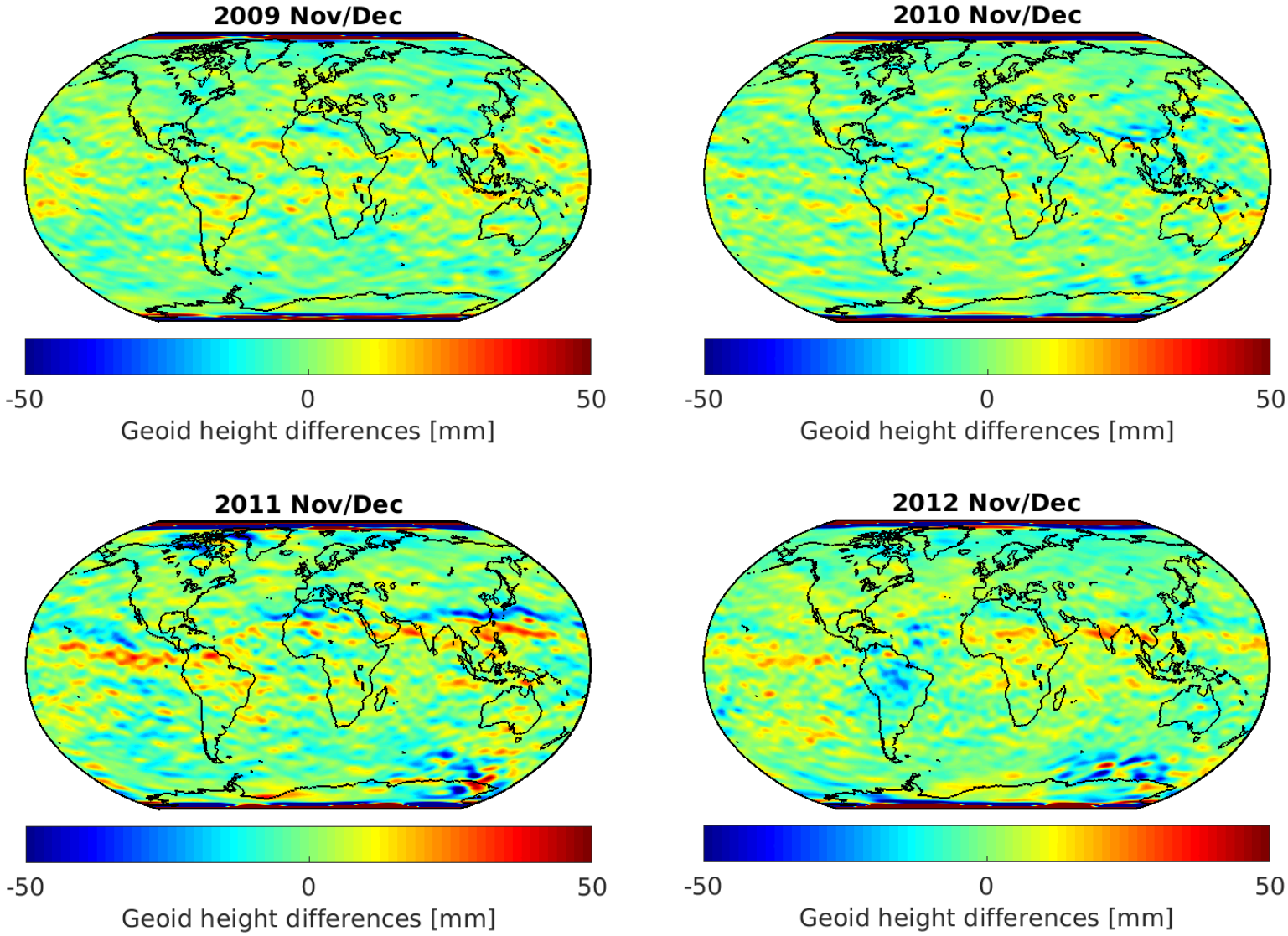
Operational PSO



Reprocessed PSO

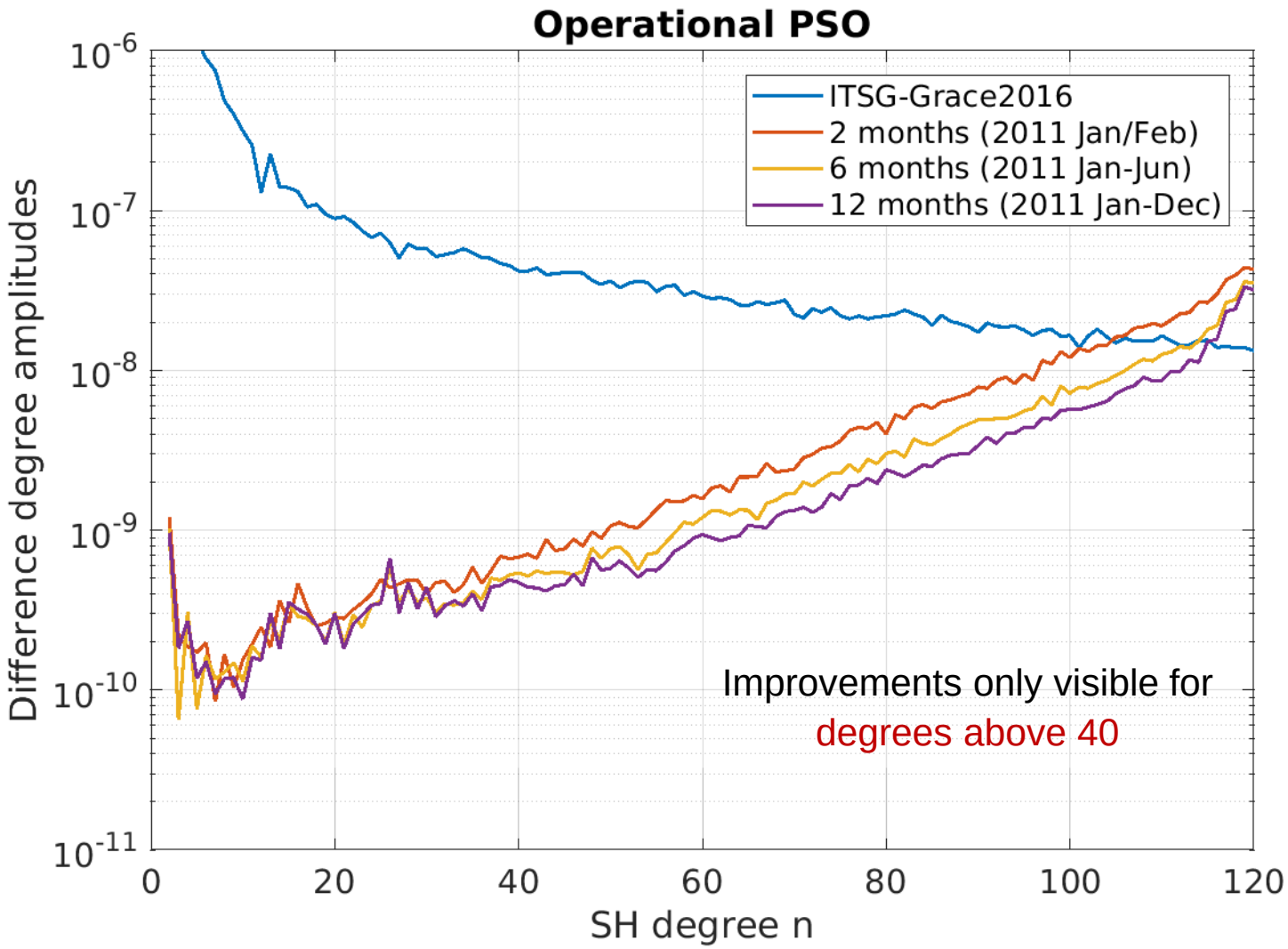


Reprocessed PSO + ACC data



Accumulated solutions

Accumulated solutions for 2011



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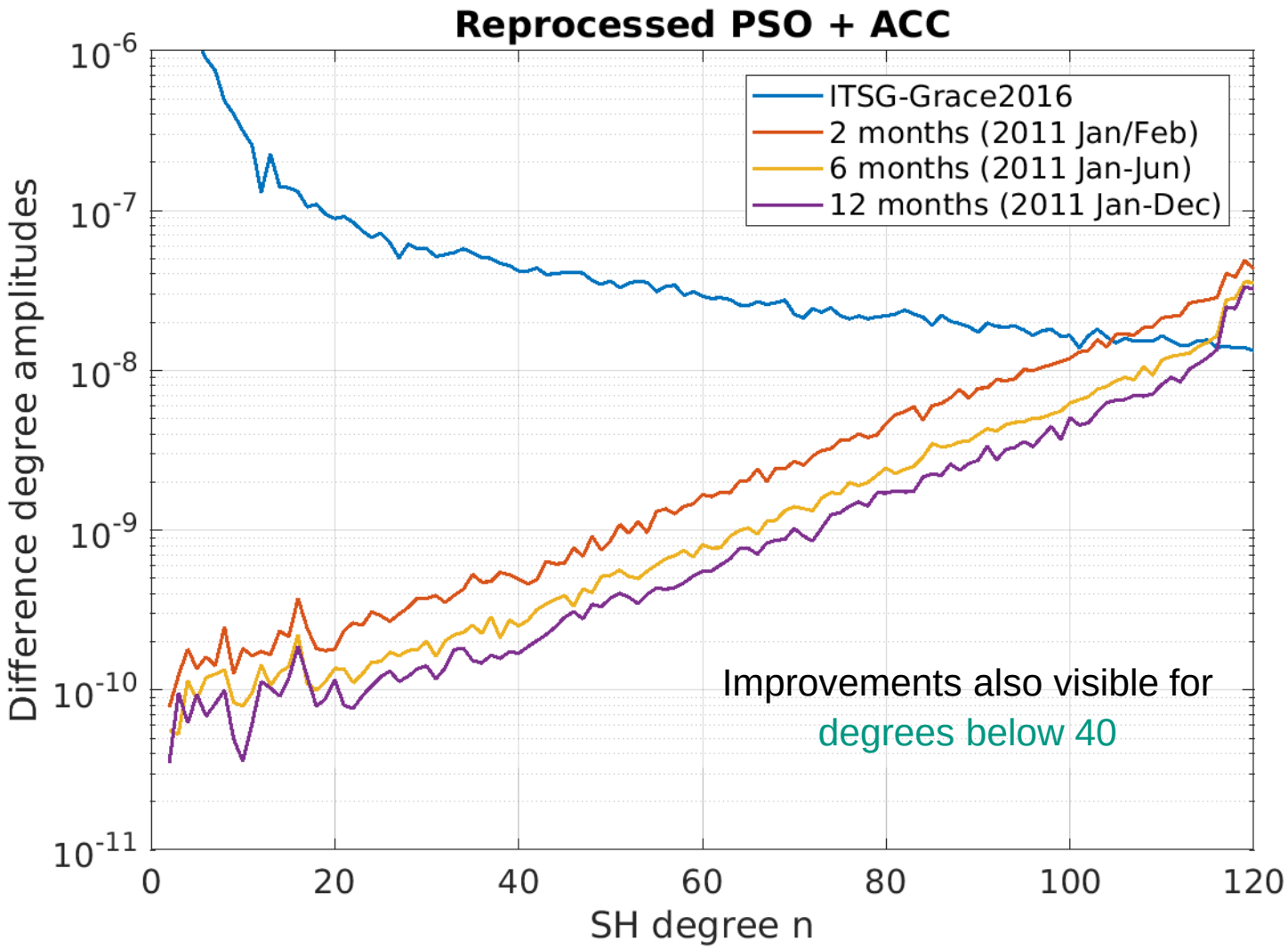
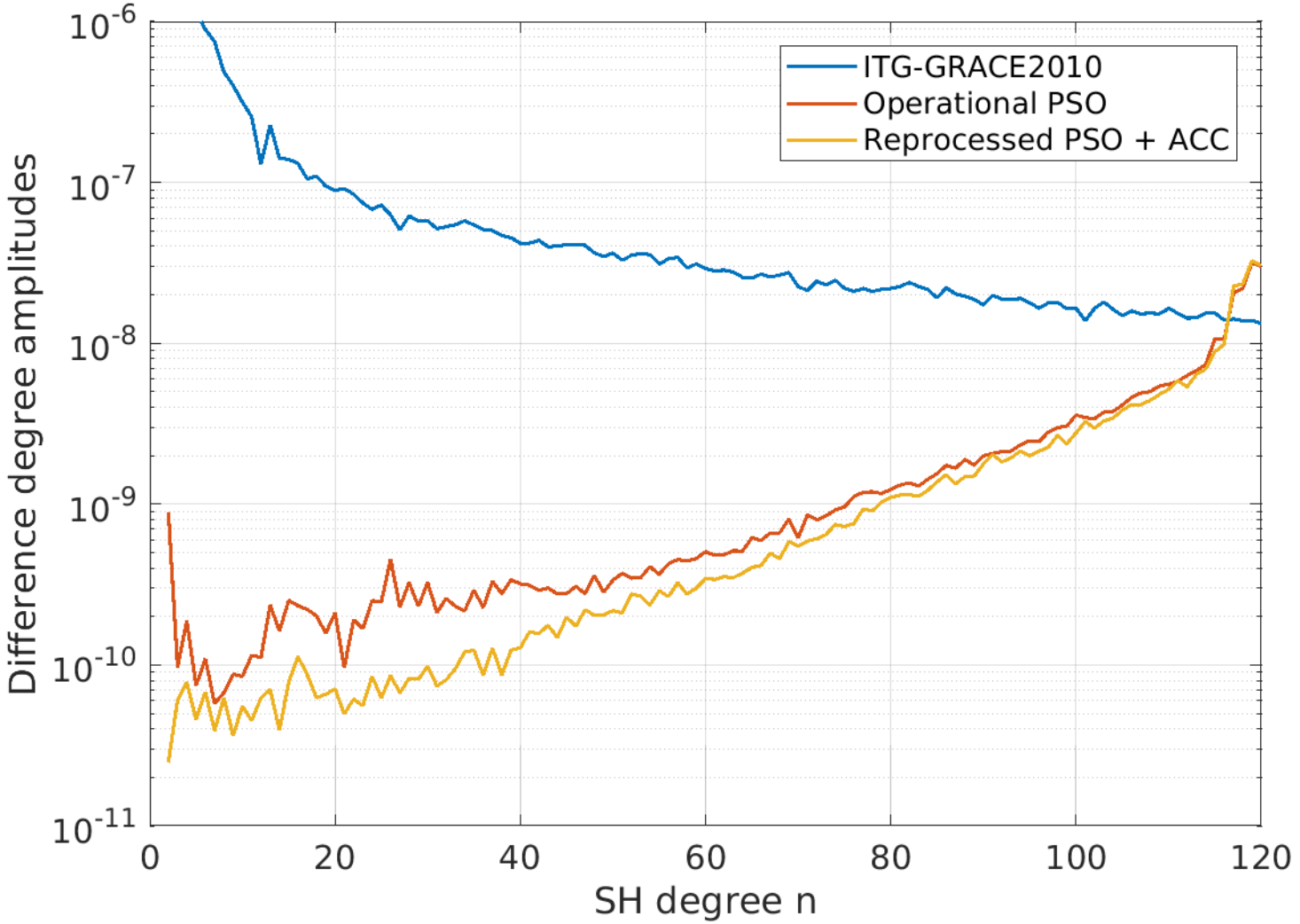


Long-term solution

Nov 2009 – Jul 2012

Long term solution: Nov 2009 – Jul 2012



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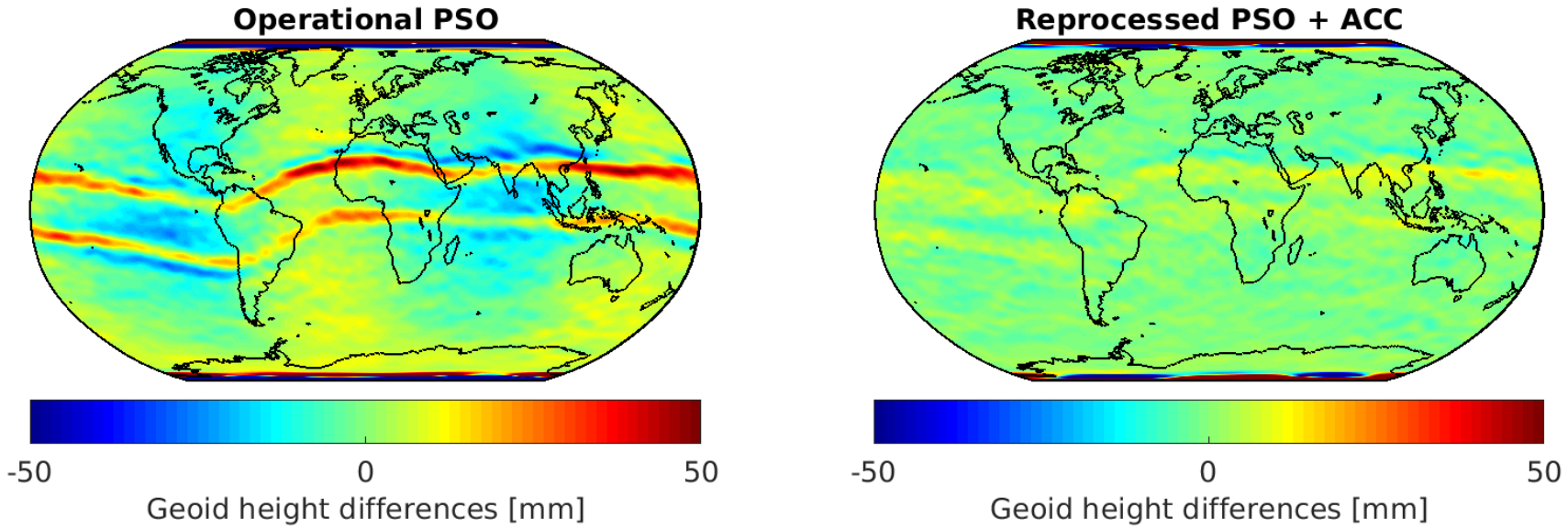
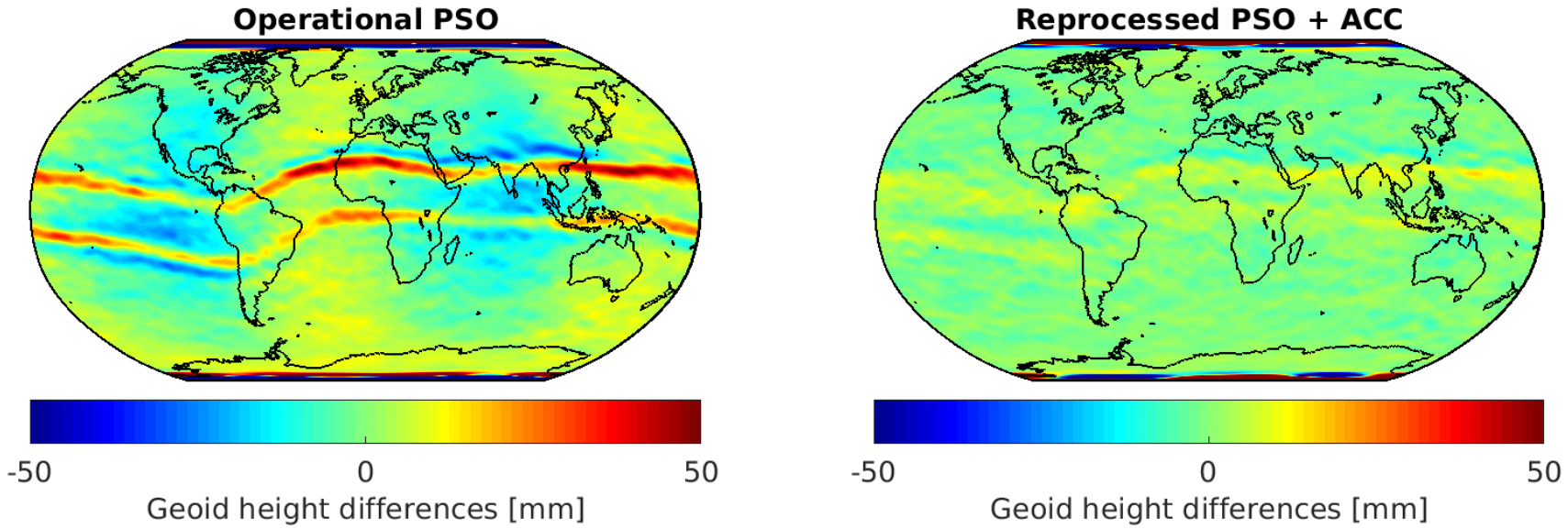


- Statistics of differences in the region $|\varphi| \leq 50°$

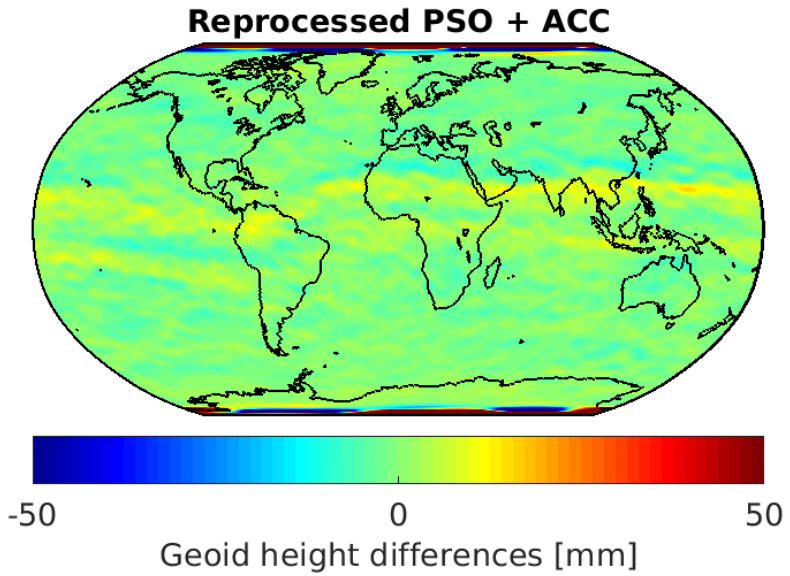
Version	Min [mm]	Max [mm]	WRMS [mm]
Operational PSO	-32.5	50.1	10.9
Reprocessed PSO + ACC	-11.7	16.7	3.3

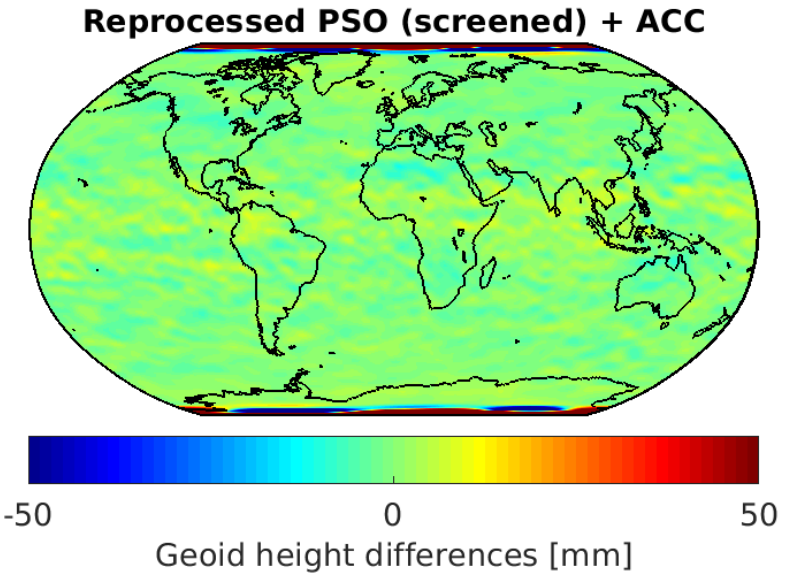
Long term solution: Nov 2009 – Jul 2012



- Current activities: Additional screening of kinematic positions
  - Screening based on covariance values of positions in the region $|\varphi| \leq 50°$
  - Threshold of 3 cm → 2.97 % reduction of observations

Long term solution: Nov 2009 – Jul 2012





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Version	Min [mm]	Max [mm]	WRMS [mm]
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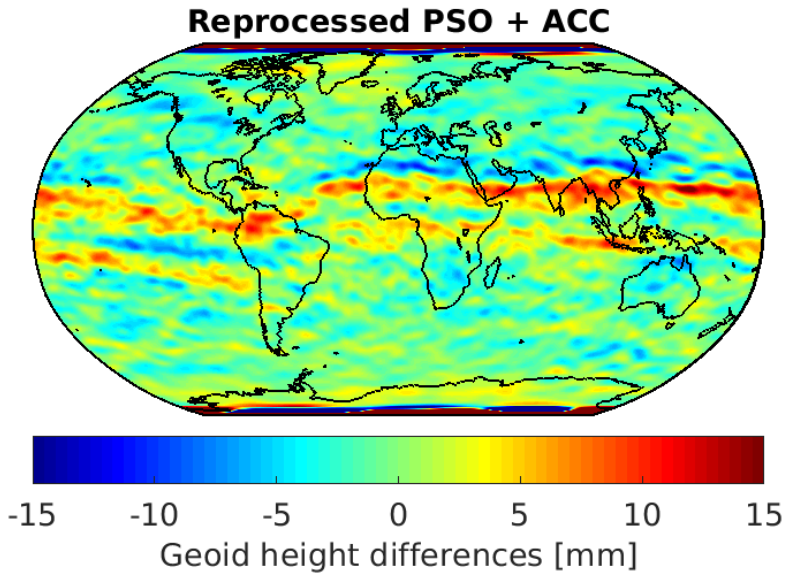
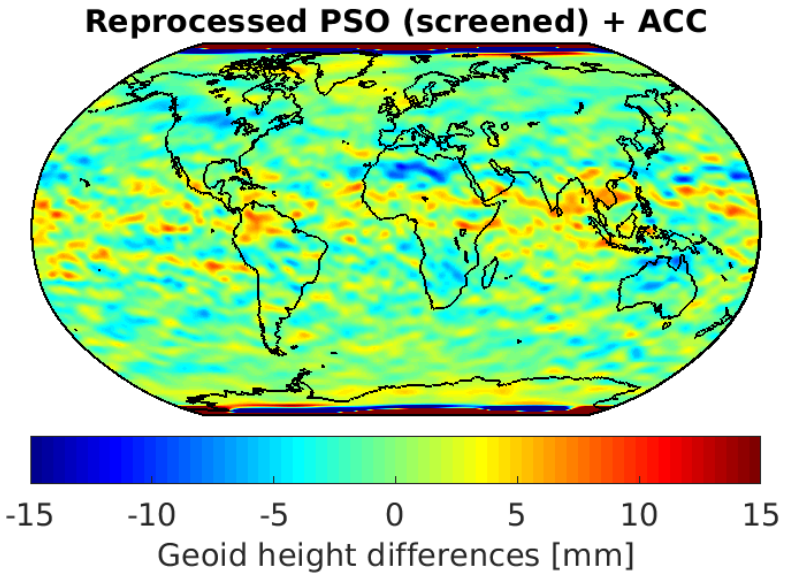
Reprocessed PSO (screened) + ACC	-11.9	9.4	2.7

Long term solution: Nov 2009 – Jul 2012





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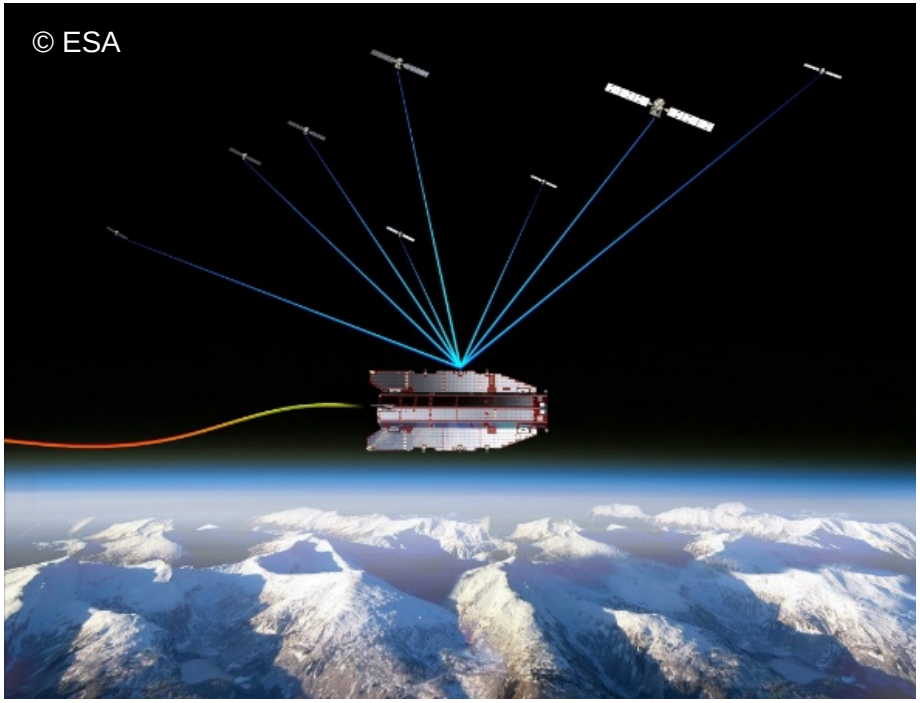
Summary

- GOCE Reprocessing Campaign
  - Complete reprocessing of the GOCE Precise Science Orbits (PSO)
  - Improved GPS-based gravity field recovery based on reprocessed PSO

- Main findings
  - Observation weighting positively impacts lower degrees (esp. $10 < n < 50$)
  - Strong reduction of artifacts along the geomagnetic equator
  - Use of GOCE accelerometer data improves lowest degrees ($n < 10$)
  - Further significant reduction of artifacts by screening based on covariance values

➢ New long-term GOCE GPS-only gravity field solution based on reprocessed PSO is available for the whole mission period (2009 – 2013)

Thank you for your attention



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